

ent who sends its child to school unvaccinated, or permits the spread of diphtheria to many other children through failure to abide by reasonable quarantine orders? And even the few little pennies which the state expends for the sanitary protection of its citizens are doled out grudgingly. Think of it! Fish worth thirty times as much as children!

Vin Mariani was advertised in this JOURNAL some two years ago. When the advertisement was

AN OLD FRIEND.

submitted we were at a loss what to do. The Publication Committee had heard that the wine contained cocaine and so wrote to the manufacturers, and asked them for a formula. A most beautiful analysis, supposedly made by a French chemist, was returned and the idea that the preparation contained cocaine was spurned with indignation. Perish the thought! But times change and sometimes wisdom comes out of darkness. The pure food and drugs law was passed—largely through the publicity given to existing rotten conditions by *Collier's Weekly*—and then we began to learn some things. The label had to tell the truth, and, lo! the label on Vin Mariani stated that the preparation contained, if memory serves, one-tenth of one grain of cocaine to the ounce! From *Collier's* of November 16th, we learn that Massachusetts, having a good anti-cocaine law, has been active in the prosecution of its provisions, has advertised certain preparations which contain cocaine and which therefore cannot be sold at retail, and has secured convictions for the violation of this statute. We read, with considerable interest in view of the former protestations of the Mariani people: "Since June seven convictions have been secured for the sale of the following preparations: Maltine with coca wine, Vin Mariani, Standard Catarrh cure." Now do you not think that is rather "going some" for a preparation which the manufacturers stated repeatedly did not contain cocaine? It must be extremely painful to the house of Mariani, benefactors to the human race in general, to have retail merchants convicted for selling their stuff in open violation of an anti-cocaine law; we feel for them in this rude shocking of their delicate sensibilities; but the subject is far too painful to dwell upon.

THE RAT AND HIS PARASITES; HIS ROLE IN THE SPREAD OF DISEASE, WITH SPECIAL REFERENCE TO BUBONIC PLAGUE.*

By B. J. LLOYD, M. D., Assistant Surgeon U. S. Public Health and Marine Hospital Service.

Although there are several hundred species of rodents included in the generic term "mus," we need not, as a rule, concern ourselves with distinctions. The "Norway," or common brown rat (*Mus Decumanus*), is so well nigh universal and, unfortunately, so intimately associated with sanitary and

shipping interests, and its habits are so nearly representative of the tribe, that we can practically pay our respects to the entire group in a discussion of this species. * * * A great deal has been said pro and con on the subject of whether or not the common rat flea will attack man. It has at last been fairly definitely settled that the rat harbors several species, and that some of them, at least, do attack man. It is quite probable that even those that do not bite man, if such there be, are not infrequently found on the body, and their mere presence is almost as much a menace as if they did, when the question of plague is considered. * * * The main object of this paper is to bring prominently before you the importance of the rat as a factor in the spread of bubonic plague in insanitary habitations. In discussing this topic, I shall reverse the usual order and ask you to hear a conclusion before I have presented the argument. I regard it as a conservative statement when I tell you that, given a filthy and insanitary environment, the rat probably many times exceeds all other factors combined in the propagation of this disease. * * *

To begin, then, it is a question whether we should regard pest as a disease of man or as a disease of rats which is readily communicable to man. It is just possible that the latter is the proper classification and that plague is primarily a disease of rats. Contrary to the general opinion, plague is a disease which progresses slowly, and only exceptionally and under circumstances with which we are none too familiar does it assume epidemic proportions. Having once gained a foothold, it plays hide-and-seek often for years, lulling its prospective victims into a false sense of security by the insidious nature of its encroachments. It is the general opinion of medical writers, however, that the city or province which harbors this infection will sooner or later be reminded in a very decided manner that the disease is not one that may be treated lightly. Whether we are able, with our present knowledge of the disease and with our improved ideas of sanitation, to prevent in the future what has inevitably resulted in the history of this disease in the past, remains to be seen. I believe that if what we know is put into practical execution, this can be done. As an example of the slow and deadly march of this disease, I have to read to you this extract from the mortuary statistics of the city of London:

In the year 1616 in London there were 9 deaths from plague; in 1617, 6 deaths; in 1618, 18 deaths; in 1619, 9 deaths; in 1620, 21 deaths; in 1621, 11 deaths; in 1622, 16 deaths; in 1623, 17 deaths; in 1624, 11 deaths; in 1625, 35,417 deaths; in 1626, 134 deaths; in 1627, 4 deaths; in 1628, 3 deaths; in 1629, 9 deaths; in 1630, 1,317 deaths.

To sum up, in a total of fifty years of plague in London, from 1601 to 1650, in twenty-five of these years the deaths numbered from 1 to 67 per annum, in eleven other years the deaths numbered from 134 to 996, while in the years 1603, 1625 and 1636 the deaths numbered respectively 36,269, 35,417 and 10,400, these being the largest numbers occurring in one year. If further evidence is wanting, I have to refer you to the number of cities that are known to be infected to-day, and remind you that nine-tenths of them are having only a few cases a month, and some of them only a few cases a year. Recognizing, then, the tortoise-like pace set by this disease, and not forgetting that it may shake off this lethargy and advance by leaps and bounds, let us consider man himself as a source of contagion. It is a common error of belief almost universal among non-medical men and even among many otherwise well-informed physicians, that plague is highly contagious. Except in the pneumonic form, which constitutes less than 5 per cent of all cases, and which differs in no wise from the bubonic type, save in the part of the body at-

* Read before the San Francisco Microscopical Society.

(This article appeared in full in The Journal April, May and June, 1904, and is such an excellent review of the subject that we here reprint a full abstract of it.—Ed.)

racked, plague can hardly be regarded as contagious. This does not apply to the handling of the internal organs with the bare hands, as some have found to their sorrow in post-mortem examinations, but refers to contact with the exterior of the body of persons suffering from, or dead of, plague. It is a well-known saying that there is no safer place in a stricken city than a sanitary plague hospital, and this saying is literally true. The following opinions on the subject are culled from Thompson's "Treatise on Plague," and are compiled by him from the writings of men whose experience and ability are too well known to be questioned, whatever may be thought of their conclusions.

Dr. Robertson, a British medical officer in Syria in 1841, writes: In reference to the contagiousness (transmissibility) or non-contagiousness of this disease, I beg to state that the result of all my experience leads me to believe that the disease originates in local causes, and that it is not highly contagious. My firm conviction is that the plague cannot be communicated from one person to another in a pure atmosphere, even by contact, but I am not prepared to assert that, if plague patients are crowded together in confined and ill-ventilated apartments, infection will not be produced, just as in typhus.

Mr. Brant remarks: As far as my experience goes, I have been led to doubt the contagious nature of the disease, or, if contagious, it must be in a very slight degree. I have had within the sphere of my observation many cases of the most complete and extensive contact, without the disease being communicated.

Sandison, of Brussa, says: The cases are numerous in which persons escaped the disease after contact with persons seized with it, even in its most malignant form.

Clot-Bey, with his corps of French physicians, "remained in hourly contact with the infected for weeks together and with but one of them taking the distemper." The Royal Academy of Medicine of France, in 1844, after a thorough and exhaustive search in Egypt, reported: "There is not a single fact which indisputably proves the transmissibility of the plague by mere contact with the sick." The experiences of more recent writers on this subject coincide with those of the writers quoted and corroborate their views. Before leaving the subject of man as a source of contagion, it must not be forgotten that under conditions of overcrowding and poor ventilation, human cases may be of considerable importance in producing the disease in others directly. Living in houses where there is plenty of sunlight and fresh air, with proper disposal of sewage, these same human beings can come in daily contact with plague cases with comparative immunity.

Contact with infected human beings being insufficient to account for the spread of the disease, we have to inquire in what way, then, does man become infected? This much we know; living plague bacilli must be brought in contact with the human body externally or internally, and while such contact does not always produce infection, it is sufficient in many instances. Direct inoculation subcutaneously, even with the slightest abrasion, such as is not infrequently produced by the nails, would, I have no doubt, result in infection in a very large per cent. of cases, even in those who live under the most favorable hygienic conditions. The mere contact of infective material, preferably plague tissue, rubbed on the unbroken skin of the guinea pig, is sufficient to infect in perhaps 90 per cent. of trials, and, judging from the number of cases in man which certainly are infected through the skin and which present no cutaneous lesion, I have no doubt that man may be infected in the same way. Without going into details (and you may draw your own conclusions from observation and from the litera-

ture of the subject) I wish to state dogmatically that while infection does take place through the respiratory and gastro-intestinal tracts, and perhaps through the genito-urinary tract, **by far the greater number of persons are infected through the skin, either with or without a discoverable cutaneous lesion.** If this be true, then what may be the source of the bacillus and how does it reach the human body? In the pneumonic form, and in those cases where we have a **lymphangitis pestis** in the pulmonary lymphatics, the sputum is, of course, dangerous. Inasmuch as these cases are not very frequent, we are led to a discussion of "sources other than rats and human cases," rats being reserved for a separate consideration. I use the word source to mean any animal that may harbor the germ, or any material outside of the animal body that may contain living plague bacilli. The evidence here is very conflicting. Competent observers say that cats have the disease but do not die of it. * * *

Various other domestic animals have been reported as suffering from or at least harboring the germs, but the evidence is not so conclusive. * * *

It may be possible that at the height of an epidemic of plague an increased virulence of the bacillus pestis, whatever an increase in virulence may mean, does enable it to become pathogenic for most of the domestic animals. At other times, the virulence of the bacillus may be so lowered that it will not produce the disease with such readiness, if at all, as it is well known that experimentally, at least, the virulence may be so lowered that it will not even kill mice, the most susceptible of all animals. If it is true that domestic animals under certain conditions harbor the germs and transmit them to man without the animal itself becoming ill, we can readily see that this is a matter of the utmost importance, as there is nothing so deadly as an enemy in ambush. * * *

What has been said of fleas and mosquitoes will apply to flies and other vermin. Fomites have long been regarded as a source of transmission, and with apparent good reason. The theory that the plague bacillus has a saprophytic existence in the soil may be mentioned as a possibility.

We now come to the consideration of the rat in particular as a means of disseminating the germs of plague. The question often asked by sanitarians is, not whether the rat is concerned in the spread of the disease, but is he the only agency? It has already been shown that the disease may be transmitted in other ways. We have now to make out a case against the rat, and there should be no difficulty in convicting him as principal, the others being accessories. It is admitted that we are unable to state satisfactorily the way in which the germ passes from rat to man. If I should shoot a man in the street in the presence of credible witnesses, I do not think a jury would acquit me because they did not see the bullet enter his body. Competent evidence can be introduced to establish the following facts regarding rats and plague: Rat plague and human plague are identical. The spread of plague follows along the lines of migration of the rat, and not necessarily along the lines of travel of human beings, unless rats accompany them, as on board ship. Plague produces a greater mortality among rats than among human beings. Plague almost invariably attacks the rats of a city before it appears in human beings. The first cases of plague in a city nearly always occur in a vicinity where infected rats have been found.

The occurrence of epidemics of plague in man without rats infection is so rare as to throw doubt upon the accuracy of such report. In one such instance (Russia) this state of affairs is offered as an explanation of the ease with which the epidemic was controlled. For hundreds of years in districts where plague prevails, the death of rats in large

numbers has been recognized by all classes as a certain omen of impending calamity, and the advent of plague among rats was sufficient to strike terror into the inhabitants and cause them to flee from their homes. The rats themselves, after a time, become panic-stricken and, losing their usual fear of man, scatter in headlong flight from the infected locality. Rats dead of plague are often found in rooms occupied by human victims. There are numerous instances in which infection in the human being has followed the handling of rats dead of the disease. Direct inoculation has been reported in one case as follows: "A dog belonging to a patient brought into his (Mr. Hill's) bedroom a rat he had killed, and plumped it down on the bed. Mr. Hill at once threw the rat away. The dog then licked his master's hand, on which there was a slight abrasion, and plague showed itself a few days later." I shall not attempt to present in detail evidence in support of the foregoing statements. They can easily be verified by reference to the literature of the subject. A few such references will be introduced, and you may follow up the subject at your pleasure. The earliest historical note connecting rats with plague is in 1st Samuel, fifth and sixth chapters, 1400 years B. C. From Renney (1851), in his account of plague in certain cities in Arabia, we have the following: "There was no particular disorder among cattle, but the outbreak of plague was preceded and accompanied by a great mortality among the rats in their houses." From Creighton, who is quoting Planck: "In the houses of families suffering from an outbreak of plague, rats are sometimes found dead on the floor. * * * Planck has seen them himself. * * * He mentions nine villages, all of them endemic seats of plague, in which the premonitory death of rats in the infected houses was testified." The same author, quoting Baber in China (1878): "The rats are first affected; as soon as they sicken, they leave their holes in troops, and after staggering and falling over each other, drop down dead. * * * The approach of bubonic plague may often be known from the extraordinary behavior of rats who leave their holes and issue onto the floors, lose their accustomed timidity and fall dead." The same author, quoting Lowry (1882): "In nearly every house in the Chinese village of Pakhoi, where the disease broke out, the rats had been coming out of their holes and dying on the floors." In addition, White, Gilder, McAdam, Forbes, Glen, Ranken, Arnaud and others make similar statements of various epidemics.

The German Plague Commission (1899) makes the following statement: Rats generally suffer from a form of plague which occurs in man rarely, if at all, namely, plague of the intestines. When thus diseased they evacuate great quantities of plague germs. It is probable that numbers of plague cases among human beings are due to contact with the evacuations of diseased rats, e. g., in the case of the flooring thus contaminated being trodden on by the naked foot. * * * Children often infect themselves by crawling on the floor and then putting their fingers in the mouth, thus getting plague with neck buboes. * * * It has therefore been proposed to wage war against rats with traps, poisons, suffocating gases, artificially induced epidemic diseases. * * *

Cantlie makes the following observation on prophylaxis: "Seeing that rats and mice are the animals which convey plague, * * * their destruction before a threatened invasion of plague is an absolute necessity if the disease is to be averted."

Manson likens a plague-threatened city to a grate in which a fire is about to be started; the coal is the human inhabitants, the sticks of kindling are the rats and the lighted match is the plague germ.

Simond observes that epidemics of plague among

rats follow a course analogous to that of the epidemic in man. The following is from Montenegro:

It may be said that the plague is a disease of rats which readily infects man. Generally, before the epidemic breaks out in a city, bodies of rats which have died of plague are found in the streets and houses. Hankin has proved that generally the first cases in a population occur precisely in those quarters in which the existence of dead bodies of rats has first been discovered, and in many cases it has been possible to demonstrate that the propagation of the epidemic from one town to another does not follow the route taken by the fugitives from the infected human population, but that taken by the rats in their flight.

Snow of Bombay established that the propagation of the plague did not follow the panic produced in the population by the human cases, but took place long after when the rats emigrated, and in the direction followed by them.

Thomson writes: Rats are more liable to pest than mankind. * * * It may be stated that plague is a disease of rats, and communicable from them to man. Generally, before an epidemic breaks out, dead rats are found in the streets and houses. At Satara, and in the infected district thereof, as at Karad in 1897, and subsequent epidemics, this was observed and commented on by the people. The first cases of plague develop precisely in those places where dead rats are first discovered, and spreads from those as foci, rather than following the routes taken by the fugitive panic-stricken inhabitants. Handling the dead bodies of rats, **in the open air**, is not dangerous; going into the warehouses or grain stores to remove them is highly dangerous and fraught with great risk, owing to the insanitary conditions of such pest centers. The fact that rats found under such conditions were pest-infected was proved repeatedly by post-mortem and bacteriological and sub-culture tests, etc.

Here we rest our case against the rat. Convicted he stands, and if you indulge me a moment longer, I would like to ask, what shall we do about it? I would like to suggest that there is one place where he should be absolutely exterminated, and that is on board ship. This is a simple matter when the vessel is empty, but the problem is not so easy of solution when the vessel is loaded. The trouble arises from the fact that if a plague-infected rat is suffocated in the bottom of the hold of a vessel, that rat cannot be removed until the cargo is discharged. Rat-guards on the lines, while it is a very important measure, do not shut out all shore rats. It is argued that it is useless to kill the rats on a vessel leaving an infected port, if you do not remove them from the vessel, an almost impossible task. I do not accept the statement that such a procedure is useless when the rats are not removed. I think the mathematical chances of infecting a port of destination are infinitely less when you have three rats in the hold of a ship dead of plague and 300 dead of suffocation, than one where you have three rats dead of plague and 300 rats that are living. In other words, I think it is a great deal better than doing nothing at all. So far as a crusade against the rats in a municipality is concerned, I think it is a very important auxiliary measure. The importance of the killing of rats in an infected city is lessened only by the many difficulties which attend such a procedure and the rapidity with which they are replaced. The pertinent question has been asked, "If plague will not exterminate rats and mice, what will?" It is probable that if all our habitations were well lighted (sunlight) and well ventilated and were otherwise in good sanitary conditions, plague would die a natural death. It is possible that if plague is allowed to fester in a filthy, overcrowded and otherwise insanitary part of a city, that after years of increase in virulence it may lose its re-

spect for even sanitary habitations, and their occupants will no longer be immune.

I shall close this paper with one other observation: Rat infection in San Francisco, while it has never been extensive, has borne a striking analogy to the infection in human beings, and plague cases occur in places where infected rats have been found; in one instance dead plague rats and a dead human victim being found in the same room.

It has been found in the application of sanitary measures in various places that poisoning rats, disinfecting, medical inspection, etc., while they are very important auxiliaries, are not nearly so effective as the tearing out of filthy habitations and the reconstruction of such buildings on good sanitary principles. This kind of work goes far toward getting rid of the rat by alteration of environment, and at the same time decreases the chances of infection from such as remain, inasmuch as the rats will seek the darker recesses of the building, and in this way will not come in contact with its human occupants nearly so frequently as they do in the close, dark rooms of many of our present buildings in Chinatown. Not only this, but it has been repeatedly noted that the danger of contracting plague from infected rats is very much lessened when the contact with the rat is in a pure atmosphere, just as it is with human cases.

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THE CONTINUANCE OF PLAGUE IN SAN FRANCISCO.*

By W. C. HASSLER, M. D., San Francisco.

On February 29th, 1904, the last verified case of bubonic plague was noted by the Department of Health. During all of the period prior to the reporting of the first case in 1900 and up to April 18, 1906, active measures were continued looking to the sanitation of the city, particularly that area then accepted as the infected section of the city, to wit: Chinatown and North Beach; and while these active measures, which included catching and poisoning of rats, from 25 to 50 of which were examined daily in the bacteriological laboratory for infection, and the spreading of chloride of lime and carbolic solution over those areas considered suspicious and

dangerous, by reason of infection having existed thereon, it is but natural to assume that the fire of April 18th and days following thoroughly eradicated any foci that remained hidden in these sections or adjacent areas and that the city might have reason to believe it had eliminated bubonic plague from its midst.

A review of the situation will, however, immediately present proofs that this city can never assume that it will remain free of infection so long as the disease exists in foreign ports, which have communication by steamship and other transportation facilities with the city and said places.

The question of interest, however, at the present time, centers upon the continuance of plague in San Francisco, excepting only that interval that occurred between 1904 and May 27, 1907, and the fact to be established is: was the infection dormant during the period of this time or was the city really clean and free of the disease; and was it reinfected from outside sources, which may have been from one or two points?

To consider the first proposition, we know that the bacillus pestis, in favorable soil, will remain active for many months; it having been stated by some writers and investigators to be many years. Had not that portion of the city where the infection originated been totally destroyed, the present epidemic might be attributed to reinfection from internal foci; but the fact that no case had occurred for so long a period of time and that the infection was not found in the hundreds of rats examined during the period, it would seem that the source of the recurrence must be looked for among the outside factors, which are two-fold.

Infection might occur at any time from rats brought to this port by foreign ships, infecting those rats that find their habitat along the water front. Secondly, the infection may have come from the bay counties adjacent to San Francisco which had not observed the sanitary precautions that San Francisco had and which were never entirely free from the disease or its menace to further spread; as was instanced in the case of the boy infected with bubonic plague, unquestionably contracted by having been bitten by a wounded squirrel, shot by him while hunting in the Contra Costa hills.

Infected rats would find it easy to travel back to San Francisco from those points along the eastern shores of the bay by means of the vessels receiving and discharging cargo between the respective points. Or, it would be possible to infect the river boats and tugs plying between San Francisco and other bay points, which in due time would become foci for the distribution of the shore rats to San Francisco.

This is but one aspect of the infection from the bay counties. It is quite possible that San Francisco was reinfected from points further distant, as the history of the first case noted in 1907 would indicate, to wit: Oscar Tomie, a sailor on the steam tug "Wizard," which plied between San Francisco,

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